(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 643 482 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **94114374.5**

(22) Date of filing : **13.09.94**

(51) Int. Cl.[6] : **H03H 9/05,** H03H 3/08

(30) Priority : **13.09.93 JP 227045/93**
13.09.93 JP 227044/93

(43) Date of publication of application :
15.03.95 Bulletin 95/11

(84) Designated Contracting States :
DE FR GB

(71) Applicant : **MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.**
1006, Oaza Kadoma
Kadoma-shi, Osaka-fu, 571 (JP)

(72) Inventor : **Ando, Daizo**
4-9-8, Hoshidanishi
Katano-shi, Osaka 576 (JP)
Inventor : **Kondo, Syuji**
7-1-608, Nakayama Satsukidai
Takarazuka-shi, Hyogo 665 (JP)
Inventor : **Oishi, Kunihiko**
2-5-5-301, Miyanosaka
Hirakata-shi, Osaka 573 (JP)

(74) Representative : **Patentanwälte Grünecker, Kinkeldey, Stockmair & Partner**
Maximilianstrasse 58
D-80538 München (DE)

(54) Electronic component and method of fabricating same.

(57) An electronic component comprising an electronic element, a case, and a lead, wherein the case is used to enclose the element and comprises upper and lower cases connected together by atomic bonding. The component is provided with through holes, with each hole used to provide a connection from the outside of the component to the element in the form of a lead arranged in the through hole to seal the hole hermetically and provides an electrical contact for the element, whereby the electronic element is packaged without deterioration due to hazardous gas generated by the conventional welding process used to seal the cases.

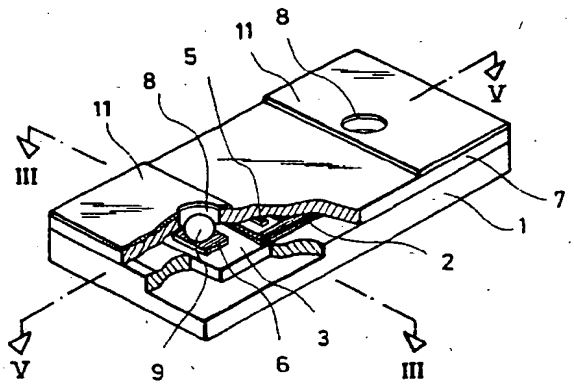


FIG.1

EP 0 643 482 A1

BACKGROUND OF THE INVENTION

This invention relates to an electronic component, especially to a structure of packaging an electronic element and a method of fabricating the same.

For some electronic elements, for example, surface acoustic wave filters, it is necessary to package the filters in outer cases with some space between the filters and the inside of the case. Conventionally, a surface acoustic wave filter has been packaged in a case consisting of upper and lower cases welded together, keeping a small space upon or over the filter. However, the frequency characteristic of the filter has often been deteriorated, since a gas generated by welding the cases together penetrates into the space upon the filter to damage the filter.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an electronic component comprising an electronic element and a case hermetically enclosing the element.

It is another object of the present invention to provide an electronic component comprising an electronic element and a case enclosing the element with some clearance between the element and the case and without deterioration of the element due to harmful gas.

It is still another object of the present invention to provide a method of fabricating an electronic component comprising an electronic element and a case hermetically enclosing the element.

In order to attain the above objects, the electronic component according to the present invention comprises an electronic element, case, and a lead, the electronic element having input/output electrodes, the case comprising an upper and lower case to be connected together to enclose the electronic element therein, the upper case having a through hole, and the lead being arranged in the through hole to fill or seal the hole hermetically.

The electronic component according to the present invention further comprises the upper and lower cases of glass connected by atomic bonding.

The electronic component is fabricated, according to the present invention, by a method comprising the steps of enclosing an electronic element having electrodes in a case with through holes, and providing the holes of said electronic component with leads for the electrodes.

The method further comprises the steps of preparing a pair of upper and lower cases of glass having edges to be connected or coupled together to surround an electronic element or elements and coupling the pair of cases by an atomic bonding method, thereby enclosing the electronic element or elements in a hermetically sealed case.

As pointed out in greater detail below of this invention provides important advantages. For example, deterioration of the element is prevented since the element is enclosed in a case hermetically sealed by atomic bonding. Also, the case includes leads for connecting terminals on the outside of the case with electrodes on said element, said leads being formed from balls placed and deformed in the through holes in the case to hermetically seal the case.

Another advantage is provided by the elimination of welding to form the cases of the component.

The invention itself, together with further objects and attendant advantages, will best be understood by reference to the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partial fragmental perspective view of an example of an electronic component according to the present invention.

Fig. 2 is a general exploded view of an example of an electronic component of the present invention.

Fig. 3 is a sectional view of the electronic component of Fig. 1 cut along the 3-3 line passing through one electrode of the element showing a step used in fabricating the lead for the component.

Fig. 4 is a sectional view passing through one electrode of the electronic component of the present invention showing a further step used in fabricating the component wherein a conductor is shown pushing down on a lead.

Fig. 5 is a sectional view of another example of an electronic component of the present invention, along the plane similar to the 5-5 line of Fig. 1 passing through two electrodes of the element.

Fig. 6 is a sectional view passing through an electrode of another example of an electronic component of the present invention wherein the enclosed element is spaced from the lower case.

Fig. 7 is a sectional view passing through an electrode of another example of an electronic component of the present invention wherein the lead comprises three balls.

Fig. 8 is a sectional view passing through an electrode of the example of Fig. 7 wherein another conductor is shown pushing down in the balls.

Fig. 9 is a sectional view passing through both electrodes of another example of an electronic component of the present invention wherein the lower case comprises two parts.

Fig. 10 is a sectional view passing through an electrode of another example of an electronic component of the present invention showing a step in fabricating the lead.

Fig 11 is a sectional view passing through an electrode of another example of Fig. 10 showing a further step in fabricating the lead.

Fig. 12 is a sectional view passing through an electrode of another example of an electronic component of the present invention wherein the outer electrode extends into the case.

Fig. 13 is a sectional view passing through both electrodes of still another example of an electronic component of the present invention wherein shielding is provided for the component.

Fig. 14 is a bottom view of the upper case of the electronic component shown in Fig. 13.

Fig. 15 is a sectional view passing through both electrodes of still another example of an electronic component of the present invention wherein shielding is provided for the component.

Fig. 16 is a bottom view of the upper case of the electronic component shown in Fig. 15.

Fig. 17, Fig. 18, and Fig. 19 are partially cut away views of examples of fabricating the lead for the electronic components of the present invention.

Fig. 20 is a partially broken perspective view of an example of a electronic component fabricated to enclose a plurality of elements.

Fig. 21 is an exploded view of the electronic component shown in Fig. 20.

DETAILED DESCRIPTION OF EMBODIMENTS

Referring to Fig. 1 and Fig. 2, an electronic component according to the present invention comprises an electronic element 3, for example, a surface acoustic wave (SAW) filter, and a case consisting of a lower case 1 and an upper case 7. The electronic element 3, typically a surface acoustic wave (SAW) filter, is composed of a 380μm thick rectangular substrate 4 consisting of quartz, lithium tantalate or lithium niobate, for example. The substrate is provided with a comb electrode 5 of 1μm thick aluminum with input/output electrodes 6 at either ends.

The electronic element 3 is packaged in a case of soda glass comprising a lower case 1 and an upper case 7. The lower case 1 is a square plate having a square hollow of 400μm depth to receive the element 3.

The upper case 7 is a plate of 300μm thickness with each through hole 8 of 0.22mm diameter for the lead. The underside edge or surface of the upper case 7 and the edge or surface of the lower case 1 are atomically bonded together to enclose the element hermetically. A space 12 is provided between the inner surface of the upper case 7 and the substrate 4. Also, the substrate is spaced from the vertical walls of the hollow 7 of the lower case 1.

In order to hermetically seal the upper and lower cases 1 and 7, both the cases are prepared by making said edges or surfaces extremely flat in terms of 10nm/20mm. The edges or surfaces are treated with a surface-active agent, e.g., 'Extran' MA02 marketed by Kanto Chemical Co., Tokyo and then washed with distilled water, to have an OH base appearing on the surface. Then, the upper and lower cases are coupled together with the SAW filter inside, and are kept in an inert gas (nitrogen for example) of 300°C for 5 minutes to seal the cases hermetically. The cases may be formed from any glass other than soda glass, e.g., borosilicate glass. The surface active agent is to be neutral. The surface active agent should not be alkaline.

As shown in Fig. 3, the upper case is provided with a lead consisting of a first conductor 9 in the form of a lump, preferably a ball of Sn of 0.20mm diameter. In Fig. 4, a second conductor 10 of Sn plate is shown, which is welded hermetically to the outer electrode 11 to push the first conductor 9 onto the electrode 6 of the electronic element.

The first conductor 9, when pushed by the second conductor 10 is expanded in the direction perpendicular to the pushing direction to fill the small gap between the conductor 10 and the inside wall of the hole 8 to seal the hole hermetically.

The first conductor 9, in the form of a ball, and the second conductor may, instead of Sn, be of Au, Cu, or any alloy of them. As a variation, the first conductor may be a ball of an elastic body covered with such conducting material or paint.

Referring to Fig. 5, the second conductor 11 may be a silver film printed on the upper case 7 using polymer silver conducting e.g., '1107-S' of Electroscience Laboratory, USA., which flows into the through hole 8 to fill the hole and contact the first conductor 9. The second conductor 11 is elongated or extended to the side surfaces 7a of the upper case. The side surfaces are provided with a notch 7b that is filled by the second conductor This elongated part or portion of the conductor 11 is often useful when the component is mounted on an electronic set.

Referring to Fig. 6, the hollow portion of the lower case 1 is provided therein with a small projection 1b to support the electronic element 3, just under the through hole. With such a projection, the substrate 4 can be supported by two projections. However, any number of small projections can be used to support a substrate. As a result, heat conduction to the element from outside heat is decreased thereby, reducing the degradation of element, since the area of the contact to transmit heat is reduced.

Referring to Fig. 7 the first conductor is illustrated as comprising three balls 9a arranged vertically in a hole 8. In Fig. 8, the three balls are shown being pushed down by a second conductor 10 to fill the small gap between the conductor 10 and the inside surface of the hole 8 to seal the hole hermetically.

Further, the hollow for the lower case 1 may be made, as shown in Fig. 9, from a plate 1b and a frame 1c bonded atomically together.

Electrical shielding is provided for the electronic component as shown in Fig. 5 and Fig. 9. In both

these figures, the upper case 7 is provided with an electric conductor film 13 on the upper surface thereof between the outer electrodes 11 but separated therefrom. The film 13 is formed when the outer electrodes are formed and can be used as an electric shield. Another electric conductor film 14 can be provided on the under surface of the lower case 1 to make the electrical shielding more effective.

Fig. 10 and Fig. 11 show another example of fabricating the lead for electronic component of the present invention. In Fig. 10, a lump or ball 9a of metal to be deformed is inserted into the through hole 8, and then the hole 8 is filled with said metal by pressing, heating or by applying ultrasonic energy. Further in Fig. 11, an electric conducting paste is provided to form a conducting film 15 to connect the ball 9a with the outer electrode 11.

Fig. 12 shows another example of the electronic component of the present invention wherein the outer electrode 11 has a part lla elongated into the through hole 8 in the form of a small hem along the under surface of the upper case. The elongated part or hem lla works as a second conductor to connect the electrode 6 to the outside of the case. Moreover, extending the conductor 11 through the hole and into the inside of the case provides a more efficient seal.

Figs. 13-16 show further examples of electrical shielding for the electrical component of this invention. In Fig. 13 and Fig. 14, the outer electrode lla is elongated through the through hole 8, to the back side of the upper case 7 as conductor 11b to form a shield layer 11e. The other outer electrode 11c is extended through the through hole 8 to form a small hem 11d on the back side of the upper case 7. A gap 16 separates the portion 11b of electrode 11a from the portion 11d of electrode 11c. Also, a large gap 13a separates 11a from 11c. The shielded layer 11e shields the SAW filter element 5 from the outside. As shown in Fig. 5 and Fig. 9a, a shield layer may be placed also on the under surface of the lower case 1, if necessary.

Referring to Fig. 15 and Fig. 16, the shield layer 11e is similar to that shown in Fig 13 and Fig. 14, except that the underside portion 11b extends to the outer edge of the upper case 7. With this arrangement, upper case anode bonding is possible, with the layer 11e connected as a anode and the lower case as a cathode. A thin layer of aluminum is preferable as the material for the elongated part 11b.

Fig. 17, Fig. 18 and Fig. 19 show a preferable process of fabricating the lead 9. Referring to Fig. 17, the through hole 8 is preferably expanded at its upper entrance 8a. Referring to Fig. 18 and Fig. 19, the through hole 8 may be expanded not only on the upper side 8a but also on the under side 8b. Also, the ball 9 may have a larger diameter than the inside diameter of the through hole, whereby the hole 8 may be filled easier.

Referring to Fig. 20 and Fig. 21, there is shown an example of an application of the present invention. For example, the electronic component may include many elements. A lower case la is provided with many hollows 2a arranged vertically and horizontally. SAW filter elements 3 are put in the hollows and an upper case 7a is positioned to cover the element. The cases may be sealed by atomic bonding, or anode bonding. Then, the balls 9 are put in the through holes and pressed by second conductors 10 to seal the holes and provides the electric connections from the inside to the outside of the component. Thus, many SAW filters are fabricated and by cutting, many discrete SAW filters can be obtained.

Instead of enclosing the SAW filters in the case, other electronic elements such as a semiconductor or other integrated circuits may be enclosed as occasion demanded. Moreover, the shape of the hollows inside the case may take the shape of the substrate to be enclosed within the case.

The embodiments described above provide a number of significant advantages. For example, the use of material, such as glass that can be bonded to enclose electrical elements provides the advantage of preventing the elements from deterioration due to gas generated by welding a conventional case to seal electrical elements inside the case.

As yet another advantage, the connection from the outside of the electronic component package to the electrical elements enclosed therein are made according to the invention in a manner that hermetically seals the holes in the package used to form the connection between the outside and inside of the package. In particular, the use of metal leads in the form of balls act to fill and seal the holes, preventing further deterioration.

Also, another advantage is provided by the present invention by the inclusion of various ways to shield the electronic package.

Of course, it should be understood that a wide range of changes and modifications can be made to the preferred embodiment described above. It is therefore intended that the foregoing detailed description be understood that it is the following claims, including all equivalents, which are intended to define the scope of this invention.

Claims

1. An electronic component comprising:

an electronic element, a case, and at least one lead, the electronic element having at least one electrode, said case comprising an upper and a lower case to be connected together to enclose the electronic element therein, the upper case having a through hole for each electrode, and said lead being arranged in the through hole to hermetically fill the hole.

2. An electronic component of claim 1, wherein the upper and lower case are glass and are connected by atomic bonding.

3. An electronic component of claim 1, wherein the lower case is provided with a projection to support the electronic element.

4. An electronic component according to claim 1, wherein said lead comprises a first conductor and a second conductor, wherein said first conductor is a lump having at least an electroconductive surface and said lump is depressed by said second conductor to contact said electrode and fill said through hole.

5. An electronic component according to claim 4, wherein said second conductor is made from a polymer conductor.

6. An electronic component according to claim 4, wherein said second conductor has an elongated part on the inner wall of the hole.

7. An electronic component according to claim 6, wherein the elongated part has a further elongated part on the under surface of the upper case.

8. An electronic component according to claim 1, wherein the electronic element is a surface-acoustic wave element comprising a substrate with at least one aluminum electrode thereon.

9. An electronic component according to claim 6, where a portion of said further elongated part provides an electrical shield for said component.

10. An electronic component according to claim 6, wherein of portion of seal further elongated part extends to the outer edge of said upper case.

11. A method of fabricating an electronic component comprising the steps of:

enclosing an electronic element with at least one electrode in a case,

providing a through hole in said case for each electrode, and

providing the electronic component with a lead to connect said electrode to the outside of the component and seal said through hole.

12. A method of fabricating an electronic component of claim 11, wherein the step of enclosing an electronic element further comprises:

preparing a pair of upper and lower cases of glass having edges to be connected together to surround the electronic element and,

coupling said pair of cases by an atomic bonding method.

13. A method of fabricating an electronic component of claim 11, wherein the step of enclosing an electronic element comprises the steps of:

preparing a pair of upper and lower cases having edges to be connected together and flatter than flatness of 10nm/20mm,

treating the pair of cases with a surface-active agent,

washing the pair of cases with pure water to have an OH base appear on the surface,

coupling the pair of cases with an electronic element inside the cases, and

keeping the pair of cases in an inert gas of temperature higher than 200°C to bond the cases.

14. A method of fabricating an electronic component of claim 11, wherein the step of providing the electronic element with a lead comprises the steps of:

putting a lump of conductive material into a through hole to contact said electrode, and

filling said through hole with said lump to seal said upper case.

15. A method of fabricating an electronic component of claim 14, wherein the step of fixing the lump further comprises fixing a second conductor into the upper case to depress the lump to fill the hole.

16. A method of fabricating an electronic component of claim 14, wherein the step of filling said through hole with said lump further comprises filling the through hole with a conductive paint.

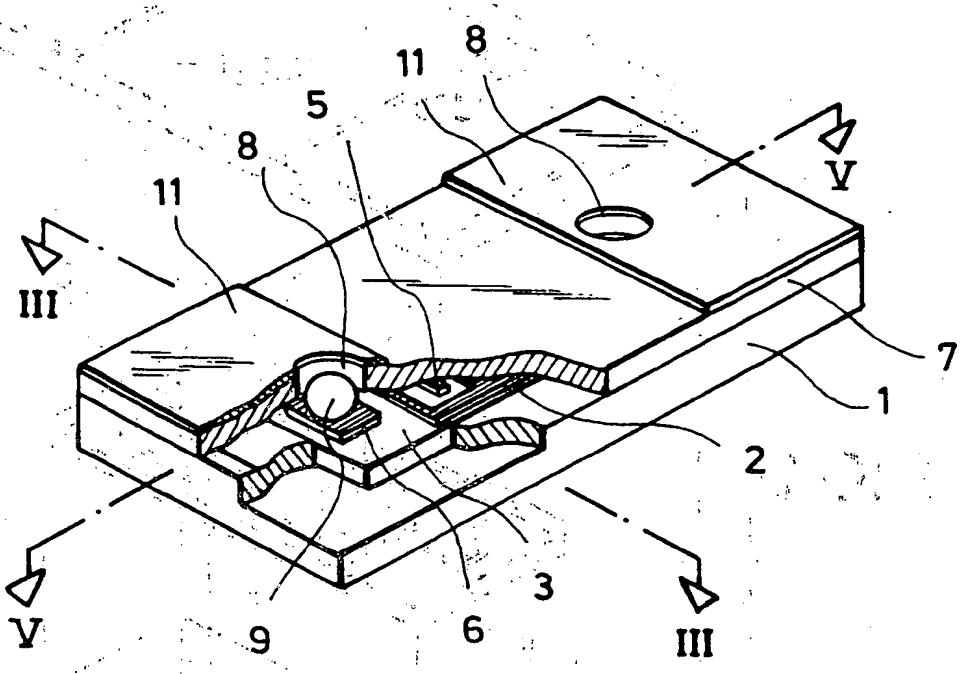


FIG.1

FIG.2

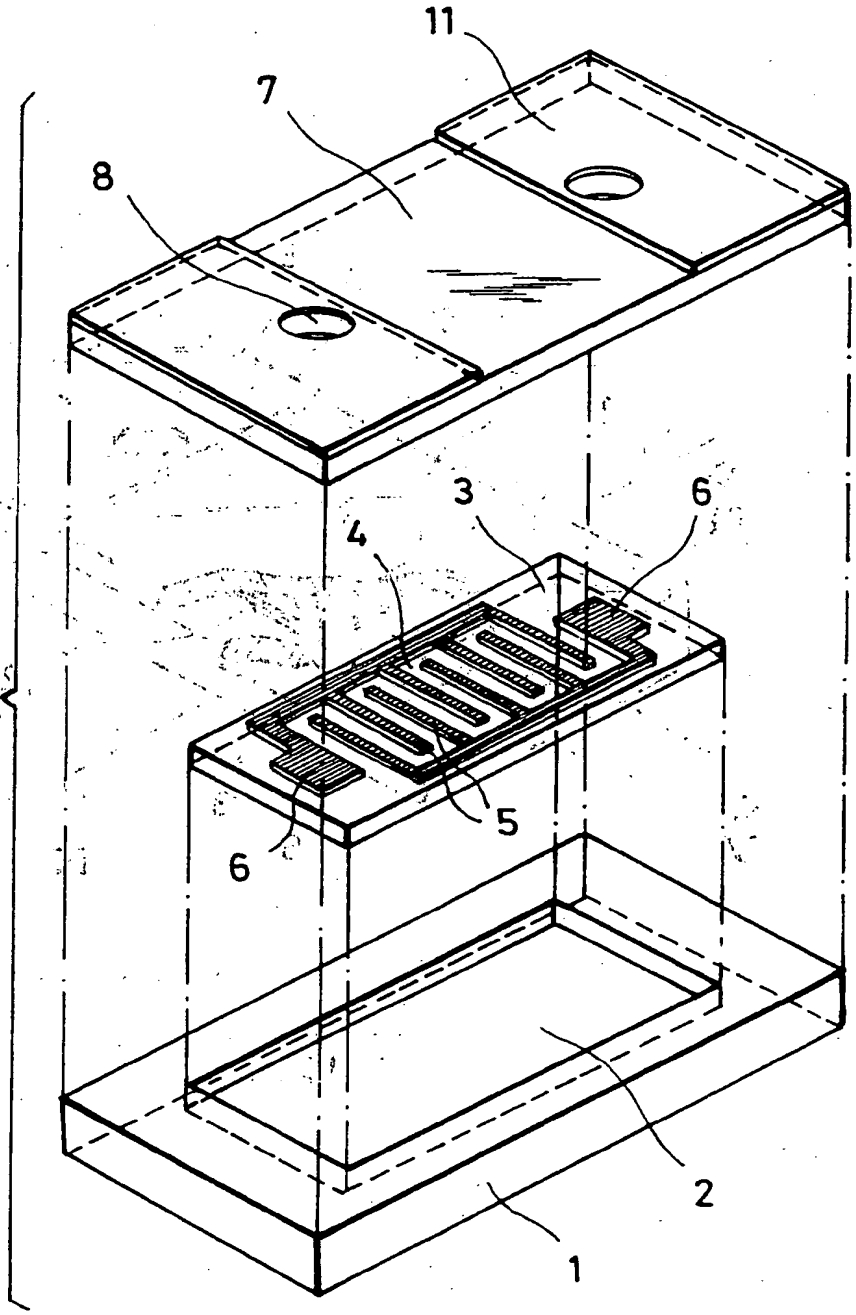


FIG.3

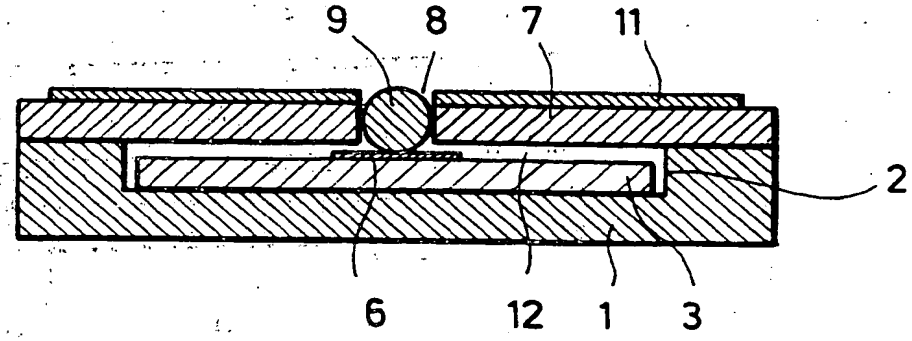


FIG.4

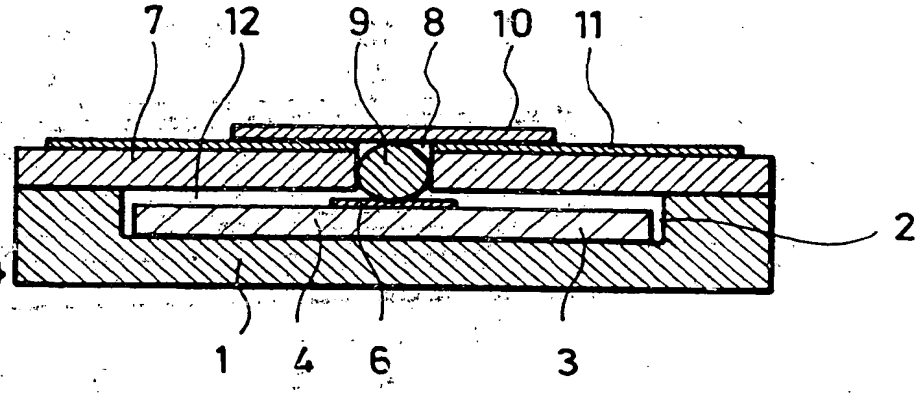


FIG.5

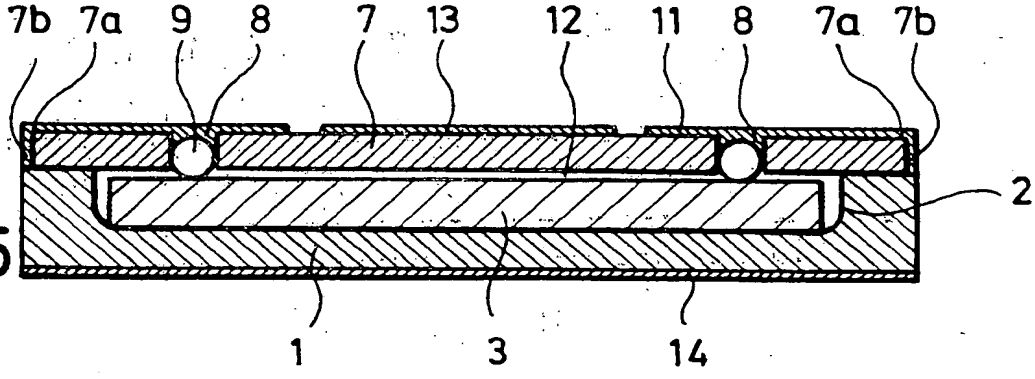


FIG.6

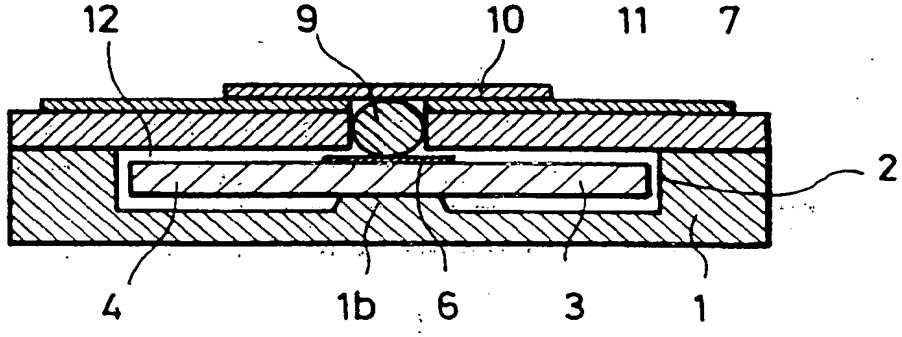


FIG.7

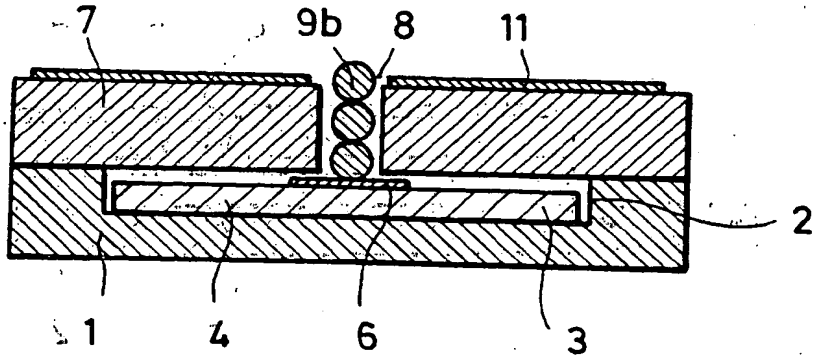


FIG.8

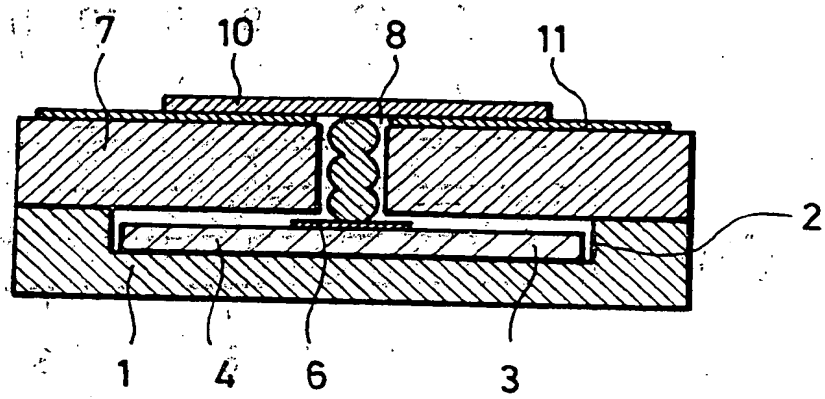


FIG.9

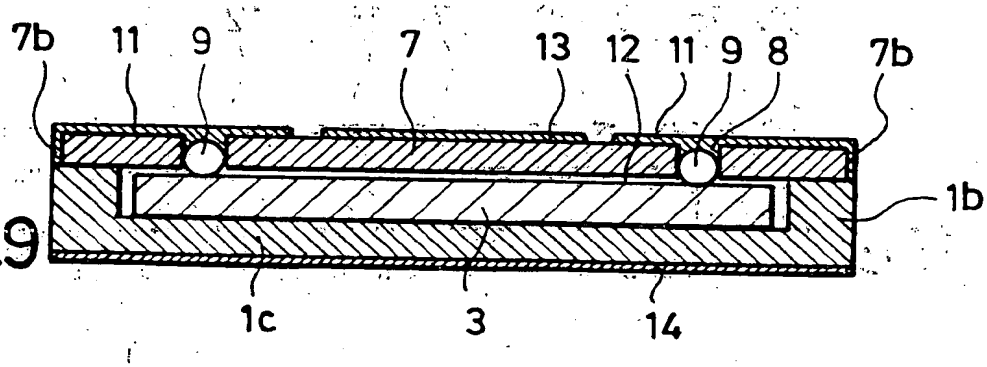


FIG.10

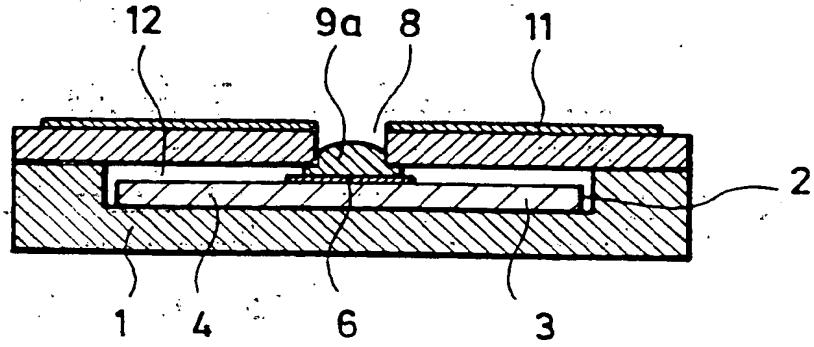


FIG.11

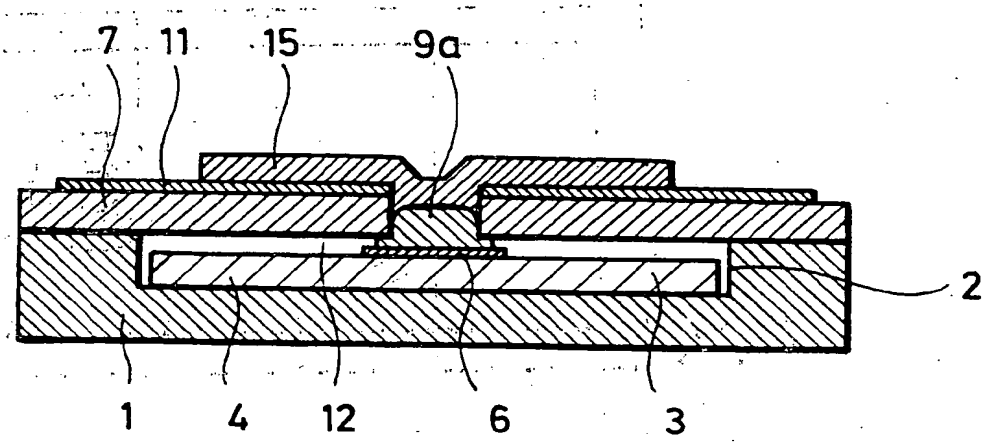


FIG.12

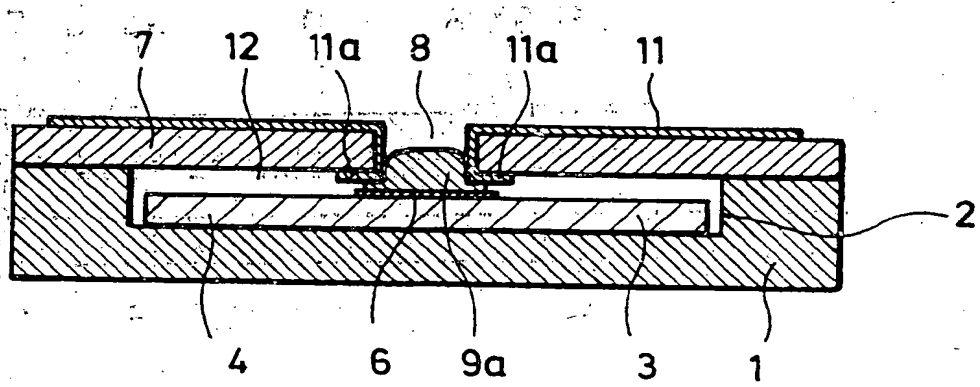
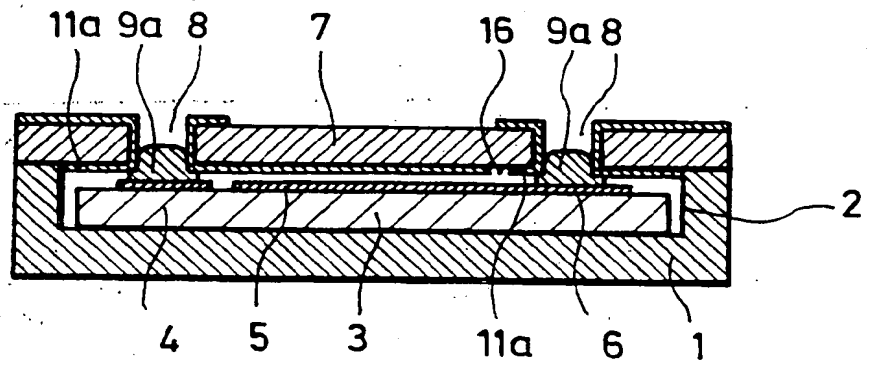


FIG.13



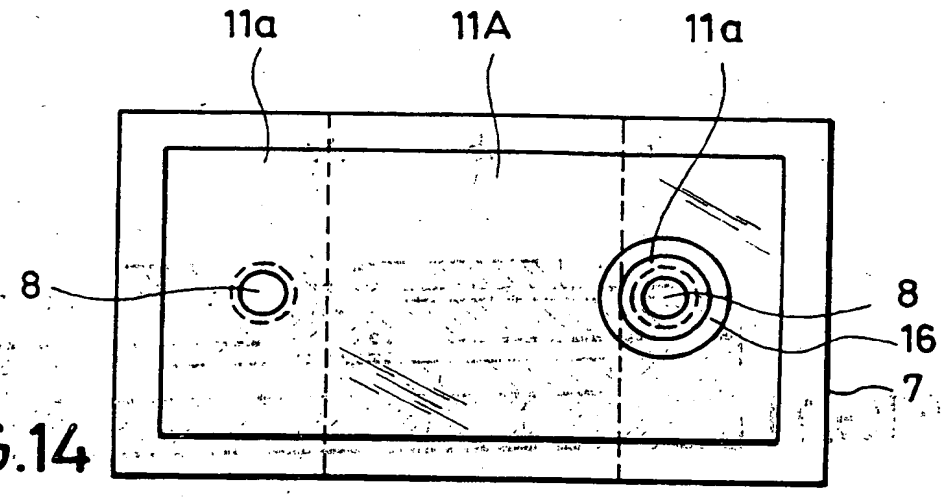


FIG.14

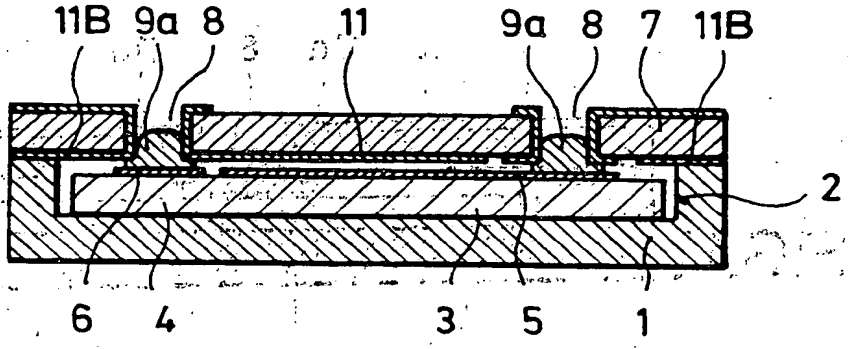


FIG.15

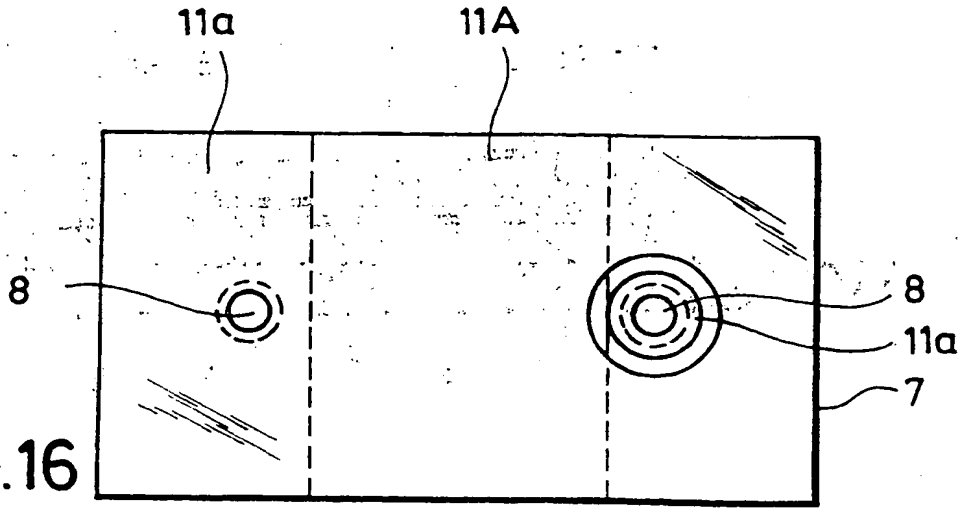


FIG.16

FIG.17

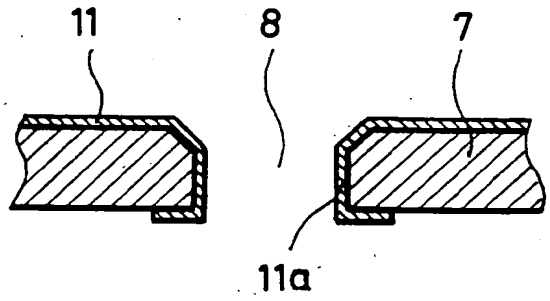


FIG.18

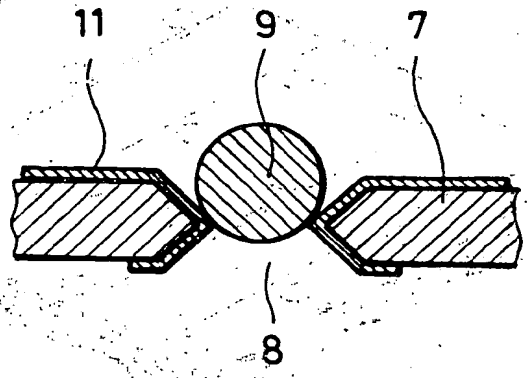
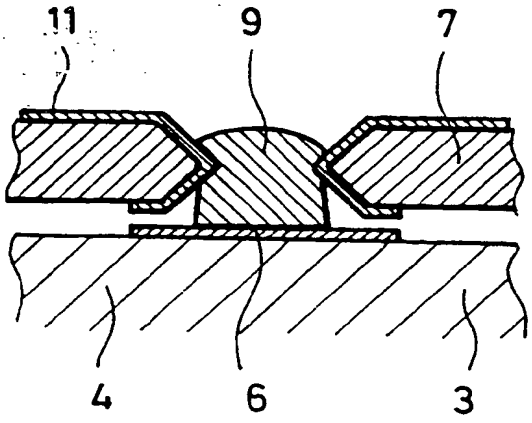


FIG.19



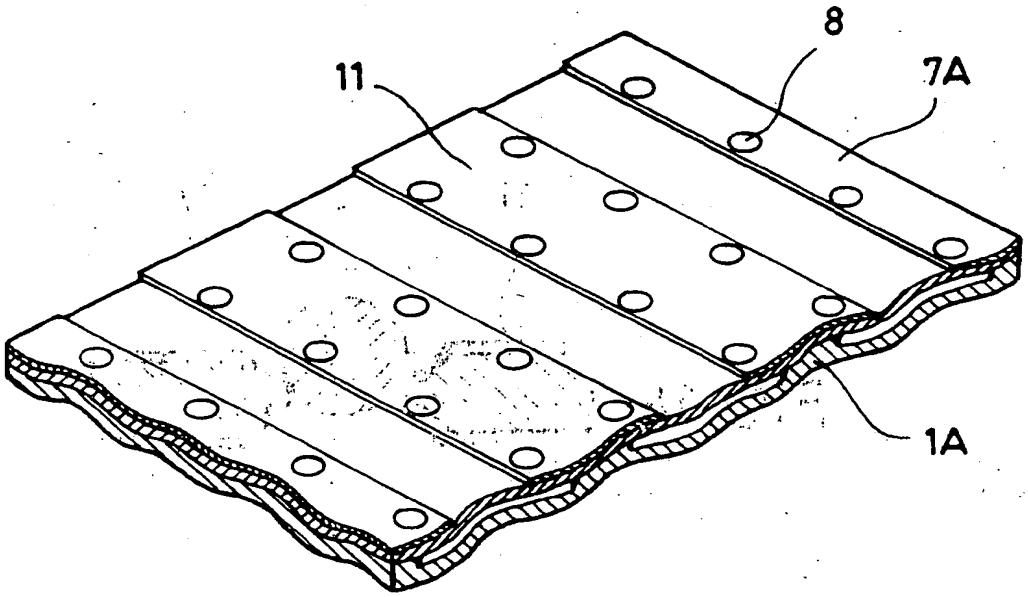


FIG.20

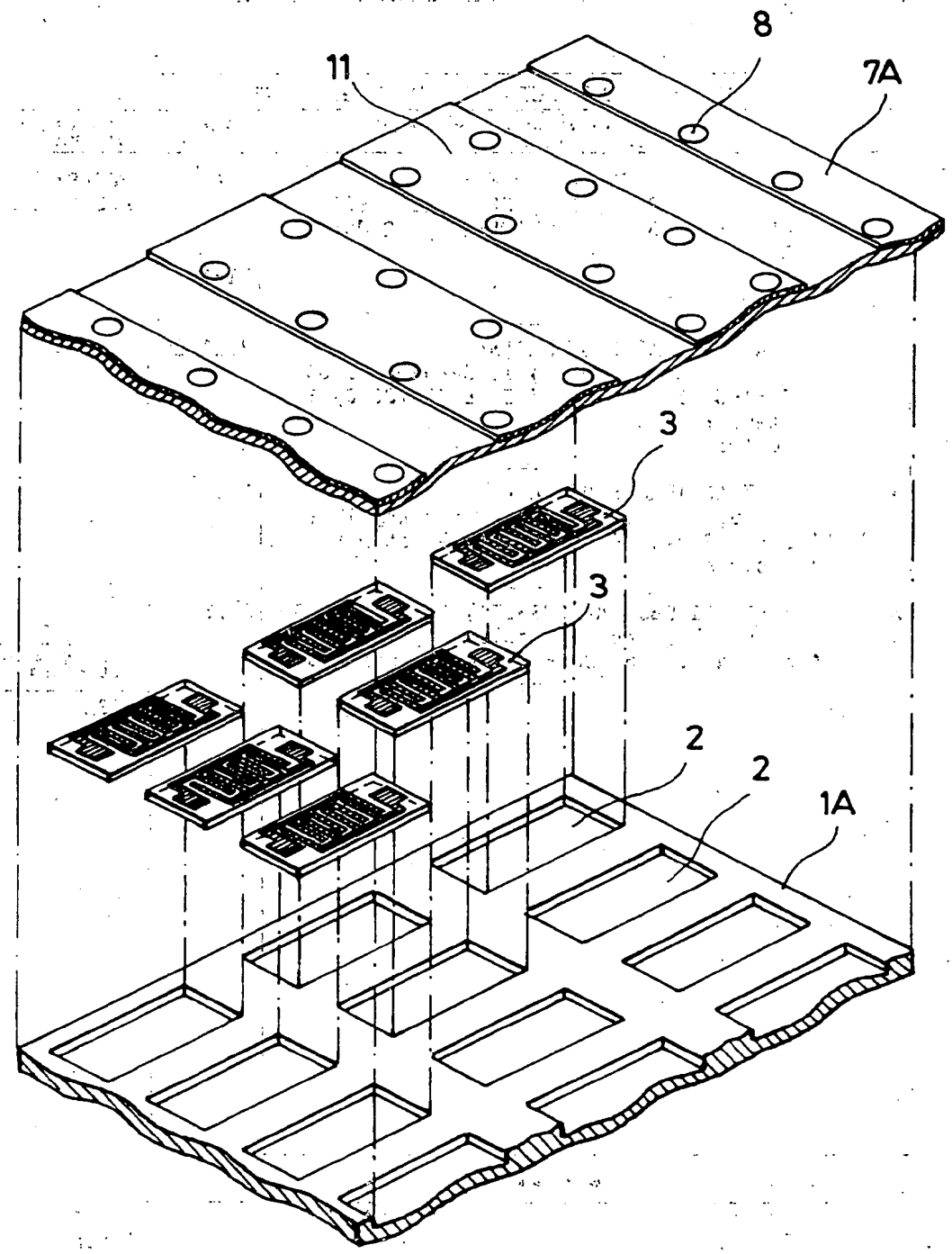


FIG. 21

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 4374

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	PATENT ABSTRACTS OF JAPAN vol. 3, no. 99 (E-132) 22 August 1979 & JP-A-54 078 692 (MATSUSHIMA) 22 June 1979	1,4,6	H03H9/05 H03H3/08
A	* abstract *	11-16	
A	PATENT ABSTRACTS OF JAPAN vol. 10, no. 5 (E-372) 10 January 1986 & JP-A-60 170 316 (NITTO DENKI TOGYO) 3 September 1985 * abstract *	2,11-16	
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 46 (E-711) 2 February 1989 & JP-A-63 241 941 (TOSHIBA) 7 October 1988 * abstract *	1-3	
A	EP-A-0 531 985 (MATSUSHITA) 17 March 1993 * column 7, line 40 - column 8, line 38 * * column 3, line 28 - column 3, line 38 *	2,13	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
H03H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 December 1994	Coppieters, C

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

THIS PAGE BLANK (USPTO)